symptom has also been generally recognised. Nodule-formation, however, occurs in many cases other than those in which it is merely a secondary symptom of brown bast.

The occurrence of diseased sieve-tubes in brown bast tissue, prior to the appearance of the disease in or adjacent to the latex vessels, has not been previously recorded, and if this is corroborated it may lead to further advance in our knowledge of this disease.

The statement that the diseased laticiferous tissue is enclosed in "stone-cell pockets" formed by the activities of wound cambiums is at variance with the results obtained by workers in the East generally. Occasionally stone-cell groups, which are abundant in normal cortex, are fortuitously enclosed within the nodule cambium at the time of its inception. The nodule cambium by its subsequent division lays down wood elements on the inside and cortical elements on the outside. It is a striking characteristic of cortex overlying old nodules, and presumably entirely derived from the nodule cambium, that stone-cells are completely absent.

G. Bryce,
Asst. Botanist and Mycologist.
Department of Agriculture, Peradeniya, Ceylon,
July 21.

Mr. Bryce is quite correct in his reference to the work of Bateson and others. In a brief note, however, historical reference to the bibliography of "brown bast" and related phenomena was not contemplated for a moment. The work of Sanderson and Sutcliffe was mentioned in consequence of the recent publication of their book on "Brown Bast." With the Editor's permission, it is proposed to deal further with the subject of this disease in a future issue of Nature.

The Writer of the Note.

The Nature of Vowel Sounds.

If you will permit me to refer at this late date to Prof. Scripture's articles in Nature of January 13 and 20 last on the nature of vowel sounds, I should like to emphasise the great service that the writer has done in pointing out that the ordinary methods of harmonic analysis are not necessarily adequate for the determination of the composition of a given tone, and may, indeed, give quite a false representation of the facts, because the sound may have inharmonic components. At the same time, it is doubtful whether his note in Nature of March 3 (p. 12) in reply to another correspondent, interpreting some of Prof. Miller's results in this field, are justifiable. Prof. Miller's curves are evidently harmonic, from the fact that they repeat themselves very faithfully at regular intervals and establish without much doubt that vowel sounds (and some others) at least *can be* so produced that they are susceptible of harmonic analysis, whether they are always of such nature or not. The fact that Prof. Scripture finds the quality of the voice constantly changing in speech is not a matter of surprise, any more than that the human face and form rarely remain exactly the same for two seconds at a time in waking hours; it need not preclude us, however, from seeking to maintain a given quality for a time for purposes of analysis and record, any more than the latter fact prevents us from sitting for portraits.

There is, however, a point in the first article that is open to distinct criticism. The author says (p. 633):—"In the analyses of vowel waves the fundamental is indicated as weak, or often almost lacking. . . . We all know that this is the strongest tone of all." It takes all the point out of scientific research if we are going to discard its plain results for what "we all know," especially if the fact of "knowledge" stands on such weak grounds as does the one here referred to. All that we are justified in saying is that a complex note is by common judgment considered as having the pitch of its fundamental; this may happen in cases in which the fundamental is known to be weaker than the upper partial or partials—a fact for which we have the authority of Ohm, Helmholtz, and the late Lord Rayleigh ("Theory of Sound," vol. 1, sec. 26). When Prof. Scripture states that fundamentals are "not of the nature of sine vibrations," he deprives us of any rational definition of the term; we could build up his type of fundamental vibration from a number of sine vibrations of shorter period, and thus produce a sound of low pitch from a number of high-pitched ones.

What I believe to be the true interpretation of Prof. Scripture's results and those of others in this field—in fact, the inescapable conclusion—is that the fundamental is, indeed, extremely weak in many of the tones produced by the voice and other musical instruments, and that it is further masked in the records by the comparative lack of sensitiveness of the ordinary recording apparatus in the lower ranges. We must then also conclude that there is something in the physiology or psychology of hearing, or in both combined, whereby the lowest component of a complex tone, the fundamental, fixes for the hearer the pitch of the whole tone, while the presence or absence of certain upper partials and their relative strength determines its quality.

The glottal puff theory is not inconsistent with the harmonic theory. Helmholtz accepted it and stated it very clearly, as seen in the following extract from his "Tonempfindungen" (Ellis's translation, p. 103):—"In order to understand the composition of vowel tones we must, in the first place, bear in mind that the source of their sound lies in the vocal chords, and that when the voice is heard these chords act as membranous tongues, and, like all tongues, produce a series of decidedly discontinuous and sharply separated pulses of air (*Luftstösse*), which, on being represented as a sum of simple vibrations, must consist of a very large number of them, and hence be received by the ear as a very long series of partials belonging to a compound musical tone." There remains to be applied a positive test, which, as Prof. Scripture points out, should not be dependent on the harmonic analysis of curves to determine whether or not Helmholtz was right in concluding that the partials of the voice tones are harmonic.

With reference to another point in the articles, it seems to me to be no more justifiable to say that the difference between the voice of a Caruso and that of a costermonger lies solely in the vocal chords than it would be to say that the tone of a reed instrument depends only on the reed, without reference to the size, shape, material, etc., of the rest of the instrument, *e.g.* that the difference between a bassoon and an oboe is only a difference of reeds.

Preston Edwards.
Clark University, Worcester, Mass., July 11.

The first essential point of the interesting communication of Mr. Preston Edwards lies in the question of the weakness of the fundamental in the tone of a vowel. This tone is that of the larynx, or the voice tone. To the ear this is always the predominating tone. We may not be able to distinguish what vowel a singer is producing, but if we can hear him at all we hear the tone he is singing—that is, the tone from his larynx. When a larynx from a freshly killed animal is subjected to a blast of air and the vocal chords are brought together, a strong tone is produced.

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Mr. Preston Edwards makes the hypothesis that a weak larynx tone arouses a complex of resonance tones in the vocal cavities, and that these are then heard with a strong lower tone corresponding to the larynx tone. We can sing all the vowels with a single strong larynx tone; that all the varied resonance tones should coincide in producing this single strong larynx tone is quite beyond imagination. It is scarcely necessary to follow this thought out; the fact remains that the larynx tone is by far the strongest tone in the vowel, both physically and for the ear.

A comparison of vowels with tones from reed instruments is inadmissible. The resonating cavities in the latter have hard walls and can force their periods on the reeds, whereas the vocal cavities have soft walls and cannot do so.

Helmholtz's theory of the vowels rests on three assumptions:—(1) The vibrations from the larynx are of the form of a simple sinusoid or of the sum of a harmonic series of simple sinusoids. (2) The vocal cavities act like resonators with hard walls. (3) The larynx tone is maintained at constant pitch. This is the condition exemplified in Helmholtz's vowel apparatus, in which tuning-forks (representing the larynx tone) are maintained electrically in vibration before brass resonators (representing the vocal cavities). Such resonators can respond only to harmonics of the fork tone. If the three suppositions are true, the harmonic theory necessarily follows.

In an interesting apparatus devised by Dr. H. Hartridge a series of weights is hung by threads of different lengths from a bar that can be set in sinusoid vibration. When the bar is started all the pendulums begin to swing, but after a few vibrations all become still except the one that corresponds to a harmonic of the period of the bar. It takes, therefore, several vibrations before the period of the bar is forced on the appropriate pendulum, and the others are forced to become still. Remembering the first fact—that a single movement of the bar starts all the pendulums—let us now drop the third supposition above and conform to the truth that the voice tone is never of a constant pitch for a single instant. In speech it changes so rapidly up and down that two successive vibrations are rarely of the same pitch. Each single vibration must start all the pendulums—that is, all the tones of the resonators—and there is no possibility that the tone of the voice can force itself on the resonators. Even retaining the first two suppositions, we are forced to conclude that any harmonic adjustment of the vocal resonators to the voice tone is impossible, because it takes at least two like periods of the voice tone to force its frequency on a resonator, whereas in actual speech the voice tone does not have two like periods in succession. The Helmholtz theory is thus impossible, because the third supposition is contrary to fact.

Let us now examine the effect of retaining the first and third suppositions while modifying the second to fit the facts. The resonators have soft walls, and any vibration aroused in them will die away rapidly. Even if the laryngeal vibration were of the sinusoid form, the resonance vibration aroused by one positive (or negative) phase would die away before the corresponding phase occurs again. To a simple sinusoid or a tuning-fork tone there is at the best only a weak response. With more complicated sinusoids or sharper tones there may be rapidly repeated overtones that evoke some response. The result is utterly different from the loud responses evoked by forks held in front of resonators with hard walls.

The moment we give up the first assumption and accept the fact that the tone from the larynx consists of a series of sharp blows, and not of continuous vibrations, all possibility of the harmonic hypothesis vanishes. A sharp blow can arouse only the free vibration of the cavity, whether hard or soft. The tones aroused are those of the cavities themselves. Their periods have no relation to the period of the blow, simply because the blow itself has no period. Even in a cavity with hard walls the aroused vibration dies away so quickly that the blow would have to be repeated rapidly in order to catch any of the dying motion.

As explained in my account in NATURE (January 13 and 20, pp. 632 and 664), every one of the three assumptions is contrary to fact. If Helmholtz had had the data we possess to-day the Helmholtz theory of the vowels would assert that the cavity tones may bear any relation to the larynx tone. The whole thing follows so easily and naturally from the facts that he would have drawn the unavoidable conclusion, and not have become involved in the difficulties and impossibilities caused by asserting that this relation must be harmonic.

Of course, this has nothing to do with the Fourier analysis. This method gives us a plot of what harmonics might be used to reconstruct a curve. The profile of a face can be resolved into a series of harmonics. The blunder occurs when someone supposes that this mathematical analysis proves anything physical. The analysis of the profile does not prove that the face was constituted of harmonics. As explained in my first article, the harmonic plot of a vowel wave represents a mathematical formula. As soon as we attempt to give a physical interpretation to this formula we are forced to reject the harmonic theory and to assert that the vowel tones may bear any relation whatever to the fundamental. The Fourier analysis still remains the only way of analysing vowel curves, and its results prove the independent theory of the vowel tones.

E. W. SCRIPTURE.

The Generation of Heath-fires.

Is Mr. Martin (NATURE, August 25, p. 811) certain that the fire seen by him had not spread through the peat from a neighbouring area recently ablaze? That such subterranean combustion may persist for many days and spread a long distance is common knowledge.

Experience shows that the surest way of preventing fires is to cut away the heather; whereas, on Mr. Martin's hypothesis, by exposing the loose soil to the direct rays of the sun this procedure should add a new risk.

HENRY BURY.

Mayfield House, Farnham, Surrey, August 26.

Life and Mind.

DURING the past six months NATURE has published many articles and reviews about life and mind, but there has been no clear and precise definition of these two terms; so permit me to submit for the serious consideration of your scientific readers a brief statement of what appears to be the true position of affairs:—

(1) We depend only upon evidence of what is called "matter" and its various *states*.

(2) Life is a state of certain kinds of matter when physical conditions are favourable.

(3) Mind is the state of some portion of a living organism—in man the cerebral cortex, where thousands of nerve-endings are concentrated.

This is no attempt to explain the *how* and *why*; but can the facts, if facts they be, be expressed more simply or concisely and with greater precision? The question may appear trivial, but it has an important bearing on other subjects which are alluded to from time to time in NATURE.

SESAMY.

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